Consommation et Affaires commerciales Canada
Bureau des brevets
Ottawa, Canada
K1A 0C9

Consumer and Corporate Affairs Canada
Patent Office

(21) (A1) 2,091,658
(22) 1993/03/15
(43) 1994/09/16

(51) INTL. CL.[5] H04M-003/60; H04M-003/42



(19)(CA) APPLICATION FOR CANADIAN PATENT (12)

# (54) Method and Apparatus for Automation of Directory Assistance Using Speech Recognition

(72) Lennig, Matthew - Canada ;
Sharp, Robert D. - Canada ;
Bielby, Gregory J. - Canada ;

(73) Same as inventor

(57) 4 Claims

## Abstract

In a telecommunication system, automatic directory assistance uses a voice processing unit comprising a database of vocabulary items and data representing a predetermined relationship between each vocabulary item and a calling number in a location served by the automated directory assistance apparatus. The voice processing unit issues messages to a caller making a directory assistance call to prompt the caller to utter a required one of said vocabulary items. The unit detects a calling number originating a directory assistance call and, responsive to the calling number and the relationship data computes a probability index representing the likelihood of a vocabulary item being the subject of the directory assistance call. The unit employs a speech recognizer to recognize, on the basis of the acoustics of the caller's utterance and the probability index, a vocabulary item corresponding to that uttered by the caller.

METHOD AND APPARATUS FOR AUTOMATION OF DIRECTORY ASSISTANCE USING SPEECH RECOGNITION.

The invention relates to a method and apparatus for providing directory assistance, at least partially automatically, to telephone subscribers.

In known telephone systems, a telephone subscriber requiring directory assistance will dial a predetermined telephone number. In North America, the number will typically be 411 or 555 1212. When a customer makes such a directory assistance call, the switch routes the call to the first available Directory Assistance (DA) operator. When the call arrives at the operator's position, an initial search screen at the operator's terminal will be updated with information supplied by the switch, Directory Assistance Software (DAS), and the Operator Position Controller (TPC). The switch supplies the calling number and the DEMS call identifier, the DAS supplies the default locality and zone, and the TPC supplies the default language indicator. While the initial search screen is being updated, the switch will connect the subscriber to the operator.

When the operator hears the "customer-connected" tone, the operator will proceed to complete the call. The operator will prompt for locality and listing name before searching the database. When a unique listing name is found, the operator will release the customer to the Audio Response Unit (ARU), which will play the number to the subscriber.

Telephone companies handle billions of directory assistance calls per year, so it is desirable to reduce labour costs by

minimizing the time for which a directory assistance operator is involved. As described in U.S. patent No. 5,014,303 (Velius) issued May 7, 1991, the entire disclosure of which is incorporated herein by reference, a reduction can be achieved by directing each directory assistance call initially to one of a plurality of speech processing systems which would elicit the initial directory assistance request from the subscriber. The speech processing system would compress the subscriber's spoken request and store it until an operator position became available, whereupon the speech processing system would replay the request to the operator. The compression would allow the request to be replayed to the operator in less time than the subscriber took to utter it.

Velius mentions that automatic speech recognition also could be employed to reduce the operator work time. In a paper entitled "Multiple-Level Evaluation of Speech Recognition Systems....", the entire disclosure of which is incorporated herein by reference, John F. Pitrelli *et al* discloses a partially automated directory assistance system in which speech recognition is used to extract a target word, for example a city name, from a longer utterance. The system strips off everything around the target word so that only the target word is played back to the operator. The operator initiates further action.

US patent No. 4,797,910 (Daudelin) issued January 10, 1989, the entire disclosure of which is incorporated herein by reference, discloses a method and apparatus in which operator involvement is reduced by means of a speech recognition system

which recognizes spoken commands to determine the class of call and hence the operator to which it should be directed. The savings to be achieved by use of Daudelin's speech recognition system are relatively limited, however, since it is not capable of recognizing anything more than a few commands, such as "collect", "calling card", operator", and so on.

These known systems can reduce the time spent by a directory assistance operator in dealing with directory assistance call, but only to a very limited extent.

An object of the present invention is to provide an improved automated directory assistance system capable of reducing, or even eliminating, operator involvement in directory assistance calls. To this end, in preferred embodiments of the present invention a speech recognition system elicits a series of utterances by a subscriber and, in dependence upon a listing name being recognized, initiates automatic accessing of a database to determine a corresponding telephone number.

The system may be arranged to transfer or "deflect" a directory assistance call to another region when it recognizes that the subscriber has uttered the name of a location which is outside its directory area.

Preferably, the system accesses the database taking account of *a priori* call distribution. *A priori* call distribution weights the speech recognition decision to take account of a predetermined likelihood that a particular destination will be sought by a caller, conveniently based upon the caller's number.

According to one aspect of the invention, automated

directory assistance apparatus for at least partially automating directory assistance in a telephone system comprises a voice processing unit comprising a database of vocabulary items and data representing a predetermined relationship between each vocabulary item and a calling number in a location served by the automated directory assistance apparatus, means for issuing messages to a caller making a directory assistance call to prompt the caller to utter a required one of said vocabulary items, means for detecting a calling number originating a directory assistance call, means responsive to a caller identifier, for example the calling number, and said data for computing a probability index representing the likelihood of a vocabulary item being the subject of the directory assistance call, and speech recognition means for recognizing, on the basis of the acoustics of the caller's utterance and the probability index, a vocabulary item corresponding to that uttered by the caller.

Embodiments of the invention may comprises means for prompting a subscriber to specify a location, means for detecting a place name uttered in response, means for comparing the uttered place name with a database and independence upon the results of the comparison selecting a message, playing the message to the subscriber. If the place name has been identified precisely as a city or location name, the message may be an NPA.

Alternatively the message could be to the effect that the number is in a different calling or directory area and offer to give the subscriber the area code. In that case, the speech recognition system would be capable of detecting a positive

answer and supplying the appropriate area code from the data base. Another variation is that the customer could be asked if the call should be transferred to the directory assistance in the appropriate area. If the subscriber answered in the affirmative, the system would initiate the call transfer.

As mentioned the recognition system preferably makes its choice based upon a predetermined probability index derived using an identifier such as calling number. The probability index will bias the selection in favour of, for example, addresses in the same geographical area, such as the same city.

The probability index need not be geographical, but might be temporal, perhaps according to time-of-day, or week or year. For example, certain businesses, such as banks, are unlikely to be called at one o'clock in the morning whereas taxi firms are. Likewise, people might call a ski resort in winter but not in summer. Hence the nature of the business can be used to weight the selection of certain portions or segments of the data base for a particular enquiry.

The discourse between the speech recognition system and the subscriber may be recorded. If the system disposes of the call entirely without the assistance of the operator, the recording could be erased immediately. On the other hand, if the call cannot be handed entirely automatically, at the point at which the call is handed over to the operator, the recording of the entire discourse, or at least the subscriber's utterances, could be played back to the operator. Of course, the recording could be compressed using the prior art techniques mentioned above.

According to a second aspect of the invention, a method of at least partially automating directory assistance in a telephone system comprises a voice processing unit comprising a database of vocabulary items and data representing a predetermined relationship between each vocabulary item and a calling number in a location served by the automated directory assistance apparatus, comprises the steps of issuing messages to a caller making a directory assistance call to prompt the caller to utter a required one of said vocabulary items, detecting a calling number originating a directory assistance call, computing, in response to the calling number and said data, a probability index representing the likelihood of a vocabulary item being the subject of the directory assistance call, and employing speech recognition means to recognize, on the basis of the acoustics of the caller's utterance and the probability index, a vocabulary item corresponding to that uttered by the caller.

An embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a general block diagram of a known telecommunications system;

Figure 2 is a simplified block diagram of parts of a telecommunications system employing an embodiment of the present invention;

Figures 3A and 3B are a general flow chart illustrating the processing of a directory assistance call in the system of Figure 2;

Figure 4 is a chart illustrates the frequency with which certain cities are requested by callers the same or other cities; and

Figure 5 is a graph of call distribution according to distance and normalized for population of the called city.

Figure 1 is a block diagram of a telecommunications system as described in US patent number 4,797,910. As described therein, block 1 is a telecommunications switch operating under stored program control. Control 10 is a distributed control system operating under the control of a group of data and call processing programs to control various parts of the switch. Block 12 is a voice and data switching network capable of switching voice and/or data between inputs connected to the switching network. An automatic voice processing unit 14 is connected to the switching network 12 and controlled by control 10. The automated voice processing unit receives input signals which may be either voice or dual tone multifrequency (DTMF) signals and is capable of determining whether or not the DTMF signals are allowable DTMF signals and initiating action appropriately. In the system described in US patent number 4,797,910, the voice processing unit has the capability to distinguish among the various elements of a predetermined list of spoken responses. The voice processing unit 14 also has the capability to generate tones and voice messages to prompt a customer to speak or key information into the system for subsequent recognition by the voice recognition unit. In addition, the voice processing unit 14 is capable of recording

a short customer response for subsequent playback to a called terminal. The voice processing unit 14 generates an output data signal, representing the result of the voice processing. This output data signal is sent to control 10 and used as an input to the program for controlling establishment of connections in switching network 12 and for generating displays for operator position 24. In order to set up operator assistance calls, switch 1 uses two types of database system. Local data base 16 is directly accessible by control 10 via switching network 12. Remote data base system 20 is accessible to control 10 via switching network 12 and interconnecting data network 18. A remote data base system is typically used for storing data that is shared by many switches. For example, a remote data base system might store data pertaining to customers for a region; the particular remote data base system that is accessed via data network 18 would be selected to be the remote data base associated with the region of the called terminal. Interconnecting data network 18 can be any well known data network and specifically could be a common channel signalling system such as the international standard telecommunications signalling system CCS 7.

Transaction recorder 22 is used for recording data about calls for subsequent processing. Typically, such data is billing data. The transaction recorder 22 is also used for recording traffic data in order to engineer additions properly and in order to control traffic dynamically.

The present invention will be employed in a telecommunications system which is generally similar to that described in US patent number 4,797,910. Figure 2 is a simplified block diagram of parts of the system involved in a directory assistance call, corresponding parts having the same reference numbers in both Figure 1 and Figure 2. As shown in Figure 2, block 1 represents a telecommunications switch operating under stored program control provided by a distributed control system operating under the control of a group of data and call processing programs to control various parts of the switch. The switch 1 comprises a voice and data switching network 12 capable of switching voice and/or data between inputs and outputs of the switching network. As an example, Figure 1 shows a trunk circuit 31 connected to an input of the network 12. A caller's station apparatus or terminal 40 is connected to the trunk circuit 31 by way of network routing/switching circuitry 30 and an end office 33. The directory number of the calling terminal, identified, for example, by automatic number identification, is transmitted from the end office switch 33 connecting the calling terminal 40 to switch 1.

An operator position controller 23 connects a plurality of operator positions 24 to the switch network 12. A data/voice link 27 connects an automated voice processing unit 14A to the switching network 12. The automated voice processing unit 14A will be similar to that described in US patent number 4,797,910 in that it is capable of generating tones and voice messages to prompt a customer to speak or key dual tone multifrequency (DTMF)

information into the system, determine whether or not the DTMF signals are allowable DTMF signals, and initiating action appropriately and to apply speech recognition to spoken inputs. In addition, the voice recognition unit 14A is capable of recording a short customer response for subsequent playback to a human operator. Whereas in US patent number 4,797,910, however, the voice processing unit 14 merely has the capability to distinguish among various elements of a very limited list of spoken responses to determine the class of the call and to which operator it should be directed, voice processing unit 14A of Figure 2 is augmented with software enabling it to handle a major part, and in some cases all, of a directory assistance call.

Each operator position 24 comprises a terminal which is used by an operator to control operator assistance calls. Data displays for the terminal are generated by operator position controller 23.

In order to provide the enhanced capabilities needed to automate directory assistance calls, at least partially, the voice processing unit 14A will employ flexible voice recognition technology and *a priori* probabilities. For details of a suitable flexible voice recognition system the reader is directed to Canadian patent application number 2,069,675 filed May 27, 1992, the entire disclosure of which is incorporated herein by reference. A priori probability uses the calling number to determine a probability index which will be used to weight the speech recognition based upon the phonetics of the caller's utterances. The manner in which the *a priori* probabilities are

determined will be described in more detail later with reference to Figures 4 and 5.

As shown in Figure 2, in embodiments of the present invention, when the voice processing unit 14 receives a directory assistance call, it determines in step 301 whether or not the number of the calling party is included. If it is not, the voice processing unit immediately redirects the call for handling by a human operator in step 302. If the calling number is included, in step 303 the voice processing unit issues a bilingual greeting message to prompt the caller for the preferred language. At the same time, the message may let the caller know that the service is automated, which may help to set the caller in the right frame of mind. Identification of language choice at the outset determines the language to be used throughout the subsequent process, eliminating the need for bilingual prompts throughout the discourse and allowing the use of less complexity in the speech recognition system.

If no language is selected, or the answer is unrecognizable, the voice processing unit 14 hands off the call to a human operator in step 304 and plays back to the operator whatever response the caller made in answer to the prompt for language selection. It will be appreciated that the voice processing unit 14 records at least the caller's utterances for subsequent playback to the operator, as required.

If the caller selects French or English, in step 305 the voice processing unit 14 uses the calling number to set *a priori*

probabilities to determine the likelihood of certain locality names being requested. The voice processing unit has a basic vocabulary of localities, e.g. numbering plan areas (NPA) which it can recognize and a listing of latitudes and longitudes for determining geographical location for calling numbers. In step 305, the voice processing unit computes probabilities for the entire vocabulary based upon distance from the locality of the calling number and population and also within the calling number's own area code or locality. In step 306, the voice processing unit issues the message "For what city?" to prompt the caller to state the name of the city, identifying the locality, and tries to recognize the name from its vocabulary using speech recognition based upon the acoustics, as described in the aforementioned Canadian patent application number 2,069,675. The voice processing unit will use the *a priori* probabilities to influence or weight the recognition process. If the locality name cannot be recognized, decision steps 307 and 308 cause a message to be played, in step 309, to prompt the caller for clarification. The actual message will depend upon the reason for the lack of recognition. For example, the caller might be asked to simply speak more clearly. Decision step 308 permits a limited number of such attempts at clarification before handing the call off to a human operator in step 310. The number of attempts will be determined so as to avoid exhausting the caller's patience.

If the locality name is recognized, the voice recognition unit determines in step 311 whether or not the locality is served

by the directory assistance office handling the call. If it is not, the voice processing unit will play a "deflection" message instep 312 inviting the caller to call directory assistance for that area. It is envisaged that, in some embodiments of the invention, the deflection message might also give the area code for that locality and even ask the caller if the call should be transferred.

If the requested locality is served by the directory assistance office handling the call, in step 313 the voice processing unit will transmit a message asking the caller to state whether or not the called party has a business listing and employs speech recognition to recognize the caller's response. If the response cannot be recognized, decision steps 314 and 315 and step 316 will cause a message to be played to seek clarification. If a predetermined number of attempts at clarification have failed to elicit a recognizable response, decision step 315 and step 317 hand the call of to a human operator. If a response is recognized in step 314, decision step 318 determines whether or not a business was selected. If not, step 319 plays the message "for what listing?" and, once the caller's response has been recorded, hands off to the human operator.

If decision step 318 indicates that the required number is a business listing, in step 320 the voice processing unit plays a message "For what business name?" and employs speech recognition to recognize the business name spoken by the caller in reply. Once again, the recognition process involves an

acoustic determination based upon the phonetics of the response and *a priori* probabilities.

If the business name cannot be recognized, in steps 321, 322 and 323 the unit prompts the caller for clarification and, as before, hands off to a human operator in step 324 if a predetermined number of attempts at clarification fail.

It should be noted that, when the unit hands off to a human operator in step 310, 317, 319 or 324, the operator's screen will display whatever data the automatic system has managed to determine from the caller and the recording of the caller's responses will be replayed.

If the unit recognizes the business name spoken by the caller, in step 325 the unit determines whether or not the data base lists a main number for the business. If not, the unit hands off to the human operator in step 326 and language, locality and selected business will be displayed on the operator's screen. If there is a main number for the business, in step 327 the unit plays a message asking if the caller wants the main number and uses speech recognition to determine the answer. If the caller's response is negative, step 328 hands off tot he human operator. If the caller asks for the main number, however, in step 329 the unit instructs the playing back of the main number to the caller, and terminates the interaction with the caller.

As mentioned earlier, the use of *a priori* probabilities enhances the speech recognition capabilities of the voice processing unit 14A. Statistics collected from directory

assistance data show a relation between the origin of a call and its destination. An *a priori* model of probability that a person at a phone number NPA/NXX asks for a locality $l_j$, is an additional piece of information which improves the recognition performance. The *a priori* model expresses the probability $P(l_j|l_i)$ of someone calling from locality $l_i$ and requesting a locality $l_j$. The probability $P(l_j|l_i)$ depends on the population of $l_j$ and the distance between $l_j$ and $l_i$. The input call locality $l_i$ is not known precisely. From the input phone number NPA/NXX, the Central Office (CO) may be identified using the Bellcore mapping. Following that step, a set of input localities related to that Central Office is considered. The probability of calling a locality $l_j$ from a phone number NPA/NXX is:

$$P(l_j|Npanxx) = \sum_{l_i \in CO} P(l_i)\,P(l_j|l_i) \qquad \text{(Eq 1)}$$

The probability P ($l_i$) of each calling locality $l_i$ associated with a CO is proportional to its population. Finally, the total recognition score for each locality is a weighted sum of the usual acoustic likelihood $\log P(Y_1Y_2\ldots Y_N|O_j)$ and the logarithm of $P(O_j(l_j)|Npanxx)$:

$$Score(O_j(l_j)) = \log P(Y_1Y_2 \ldots Y_N|O_j) + \lambda \log P(o_j(l_j)|Npanxx) \quad \text{EQ 2}$$

where $O_j$ is the orthography of the location $l_j$. An *a priori* model may be arranged to distinguish between populations having French or English as their first language. Knowing the language selected by the user, the population using that language is used to estimate $P(l_j|l_i)$ . A minimum value of 10% of the population is used to avoid excessively penalizing a language.

As an example, an *a priori* probability model developed using directory assistance data collected in the 514, 418 and 819 area codes, is shown graphically in Figure 4. In each of these area codes, the number of requests to and from each NXX was collected; faint lines appear indicating the frequency of "any city requesting Montreal", "Montreal requesting any city", and "any city requesting itself". From these data it was possible to estimate the parameters of a parametric model predicting the probability of a request for information being made for any target city given the calling (NPA) NXX. The parameters of the model proposed are the called city's population and the distance between the two cities. Where o is the originating locality, d is the destination locality, and S is the size of a locality, then the likelihood of a request about d given o is

$$L(d|o) = S(d) * f(|\vec{o}-\vec{d}|)$$

The normalized likelihood is

$$\bar{L}(d|o) = 0.60 \frac{l(d|o)}{\sum_{\text{over all } d'} L(d'|o)}$$

When the destination city is also the origin city, the likelihood is higher, so this is treated as a special case.

It is assumed that 60% of DA requests are placed to localities including the originating locality as governed by the equation above, and an additional 40% of DA request are for the originating city, giving

$$P(d|o) = \bar{L}(d|o), \quad d \neq o$$
$$= \bar{L}(d|o) + 0.40, \quad d = o$$

Intuitively, the function f(o,d) varies inversely with the distance between cities. In order to better define the function, a table of discrete values for certain distance ranges was derived from community of interest data collected in the three Quebec area codes. The distance units used in this section are the ones used by Bellcore to maintain geographical locality coordinates in North America. One kilometre is roughly equal to 1.83 Bellcore units.

The discrete function values f computed for a given distance range in the province of Quebec are given in the Table below for each area code. Since the goal was to obtain an *a priori* model for the entire province, the values for f(o,d) were computed for the province as a whole through factoring in the probability of a call originating in each area code. This was estimated to be

in proportion to the number of NXX's per area code relative to the province as a whole.

This gives

f(Province} = {0.40 f(514)} + {0.27 f(819)} + {0.33 f(418)}

| distance | 514 | 819 | 418 | Province |
|---|---|---|---|---|
| 0-25 | 1.0 | 1.0 | 1.0 | 1.00 |
| 26-50 | 0.9 | 0.3 | 0.7 | 0.67 |
| 51-75 | 0.4 | 0.0 | 0.2 | 0.23 |
| 76-100 | 0.1 | 0.0 | 0.3 | 0.14 |
| 101-125 | 0.1 | 0.0 | 0.1 | 0.07 |
| 126-150 | 0.1 | 0.0 | 0.1 | 0.07 |
| 151-175 | 0.0 | 0.0 | 0.2 | 0.07 |
| 176-200 | 0.0 | 0.0 | 0.0 | 0.00 |
| >200 | 0.0 | 0.0 | 0.0 | 0.00 |

Given the sparseness of data, the model for obtaining weights as a function of distance was converted from nonparametric to parametric. For this purpose, a least square fit was performed on the data from ranges 26-50 to 151-175. The distance value used in the fitting process was the median distance in each range. An analysis of various function forms for the regression showed that the form below provided the closest fit to the collected data:

$$f'(\text{distance}) = \{A/\text{distance}\} + B$$

The best coefficients obtained from the analysis were

$$A = 33.665$$

$$B = -0.305$$

This function reaches zero when the distance is equal to 196. In order to not eliminate the possibility of handling a DA request when the distance was greater than this value, the function was modified to accommodate distances of up to twice the maximum distance between any pair of cities with population 10,000 or greater in the province. The two most distant cities that matched this criteria were Rouyn-Noranda and Gaspe at a distance of 2,103 units. The maximum distance at which f would be zero was set to be 4,207 distance units. The function switches to a negative slope linear function at the point where the predicted value of f is 0.01. This corresponds to a distance value of 167.

The final f becomes

$$\min(1,\ (33.65/d) - 0.305,\ d <= 167$$

$$0.01,\ d > 167$$

The fit of this model to the collected data, labelled "nonparametric model:, is shown in Figure 5.

In order to determine the effects of the *a priori* model on recognition rate, the model was applied to simulated DA requests, and each token in the test set was rescored to take *a priori* likelihood into account. The function used for rescoring was

$$\text{weighted score} = nas + K \log\{P(o|d)\},$$

where nas is the normalized acoustic score, the acoustic score over the number of frames in the utterance. The proportionality constant K was trained to maximize the recognition rate over the province of Quebec. The distribution of tokens in the test set is normalized to be that predicted by the *a priori* model. For this reason a correctly recognised simulated DA request from a city to the same city carries more weight when computing recognition rate than does a request for a small distant city with a correspondingly low *a priori* probability. A recognition rate was thus determined per city and then the overall provincial recognition rate was computed by taking the sum of the rate for all cities in proportion to their respective populations. The only assumption made in applying the model was that the calling NPA/NXX is known, which allows the utterance to be rescored by mapping it to all cities corresponding to the given entry in the Bellcore database.

The *a priori* model was further refined in order to avoid favouring the bigger cities unduly, as the recognition rate on these based on acoustics alone was already above average. For this purpose, constants were introduced in the model corresponding to population ranges over the target cities in order to reduce the effective populations. These constants were not applied to the modelled distribution of requests since this would invalidate the method for computing the provincial recognition rate. The function defining likelihood becomes

$$L(d|o) = K_{r(d)} S(d) f(|\vec{o}-\vec{d}|)$$

where r(d) is a range of destination locality population for which the constant K applies. The best ranges and their associated constants were then determined empirically from a development set.

Thus, using *a priori* call distribution, and flexible voice recognition, embodiments of the present invention are capable of automating at least the front end of a directory assistance call and in some cases the entire call.

The embodiment of the invention described above is by way of example only. Various modifications of, and alternatives to, its features are possible without departing from the scope of the present invention. For example, the voice processing system might be unilingual or multilingual rather than bilingual. The *a priori* probabilities need not be geographical but might be determined in other ways. For example, they might be determined according to time-of-day or season of year, or determined with reference to a history of calls placed by a particular caller or callers.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE RIGHT OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Apparatus for at least partially automating directory assistance in a telephone system, comprising a voice processing unit comprising a database of vocabulary items and data representing a predetermined relationship between each vocabulary item and a calling number in a location served by the automated directory assistance apparatus, means for issuing messages to a caller making a directory assistance call to prompt the caller to utter a required one of said vocabulary items, means for detecting a calling number originating a directory assistance call, means responsive to the calling number and said data for computing a probability index representing the likelihood of a vocabulary item being the subject of the directory assistance call, and speech recognition means for recognizing, on the basis of the acoustics of the caller's utterance and the probability index, a vocabulary item corresponding to that uttered by the caller.

2. Apparatus as claimed in claim 1, further comprising means for transmitting a message to the caller giving the required directory number corresponding to the vocabulary item.

3. Apparatus for at least partially automating directory assistance in a telephone system, including voice processing

means for issuing to a directory assistance caller a message inviting the caller to utter the name of a location, recognizing the place name from the utterance, determining whether or not the location is within the area served by the automatic directory assistance apparatus and, in the event that it is not, playing a message to the caller inviting the caller to direct the directory assistance request to an alternative locality.

4. A method of at least partially automating directory assistance in a telephone system comprises a voice processing unit comprising a database of vocabulary items and data representing a predetermined relationship between each vocabulary item and a calling number in a location served by the automated directory assistance apparatus, comprises the steps of issuing messages to a caller making a directory assistance call to prompt the caller to utter a required one of said vocabulary items, detecting a calling number originating a directory assistance call, computing, in response to the calling number and said data, a probability index representing the likelihood of a vocabulary item being the subject of the directory assistance call, and employing speech recognition means to recognize, on the basis of the acoustics of the caller's utterance and the probability index, a vocabulary item corresponding to that uttered by the caller.

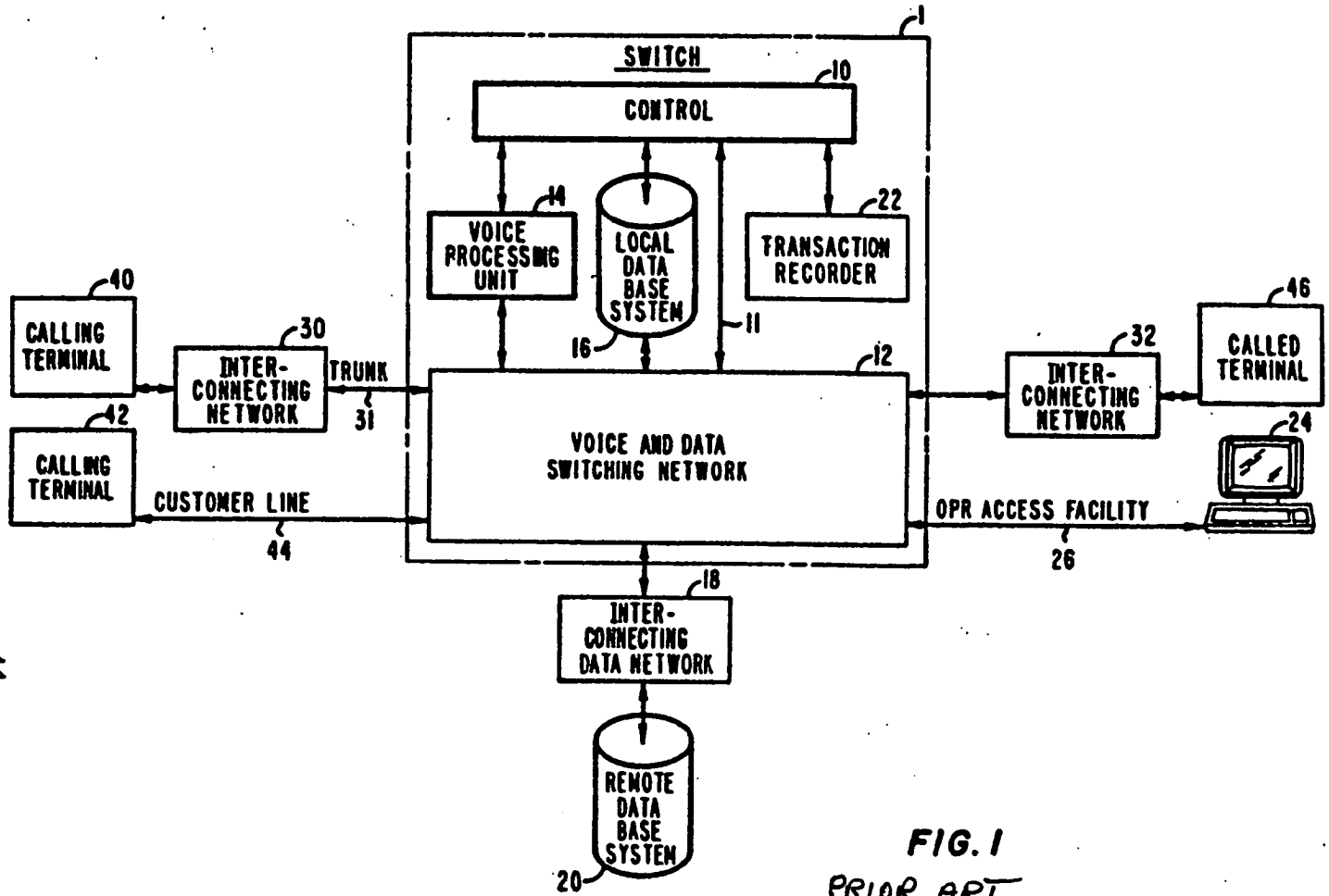



FIG. 1
PRIOR ART

Thomas Adams et al
AGENT FOR APPLICANT

2091658

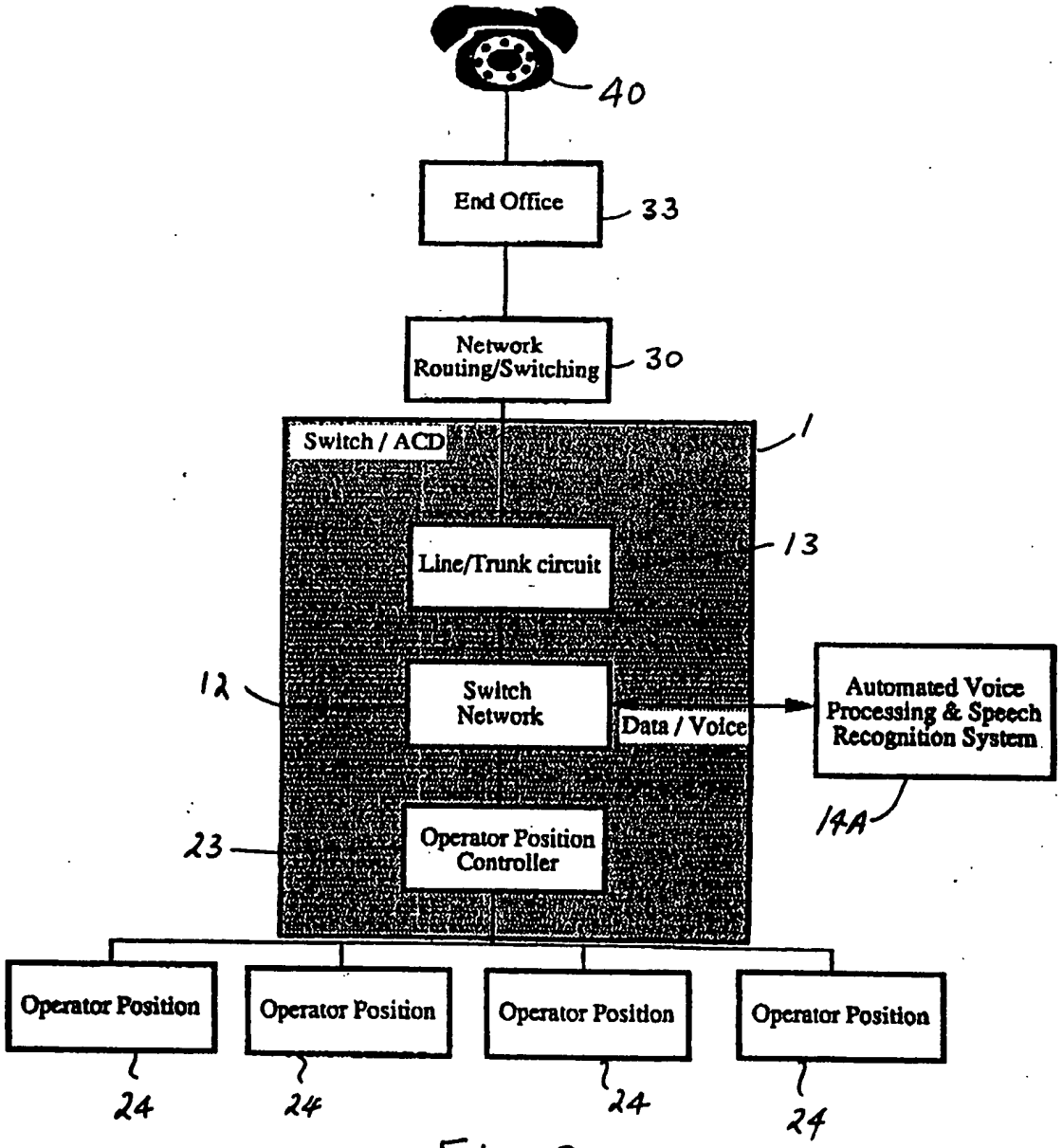



FIG. 2

Thomas Adams & Moore
AGENT FOR APPLICANT

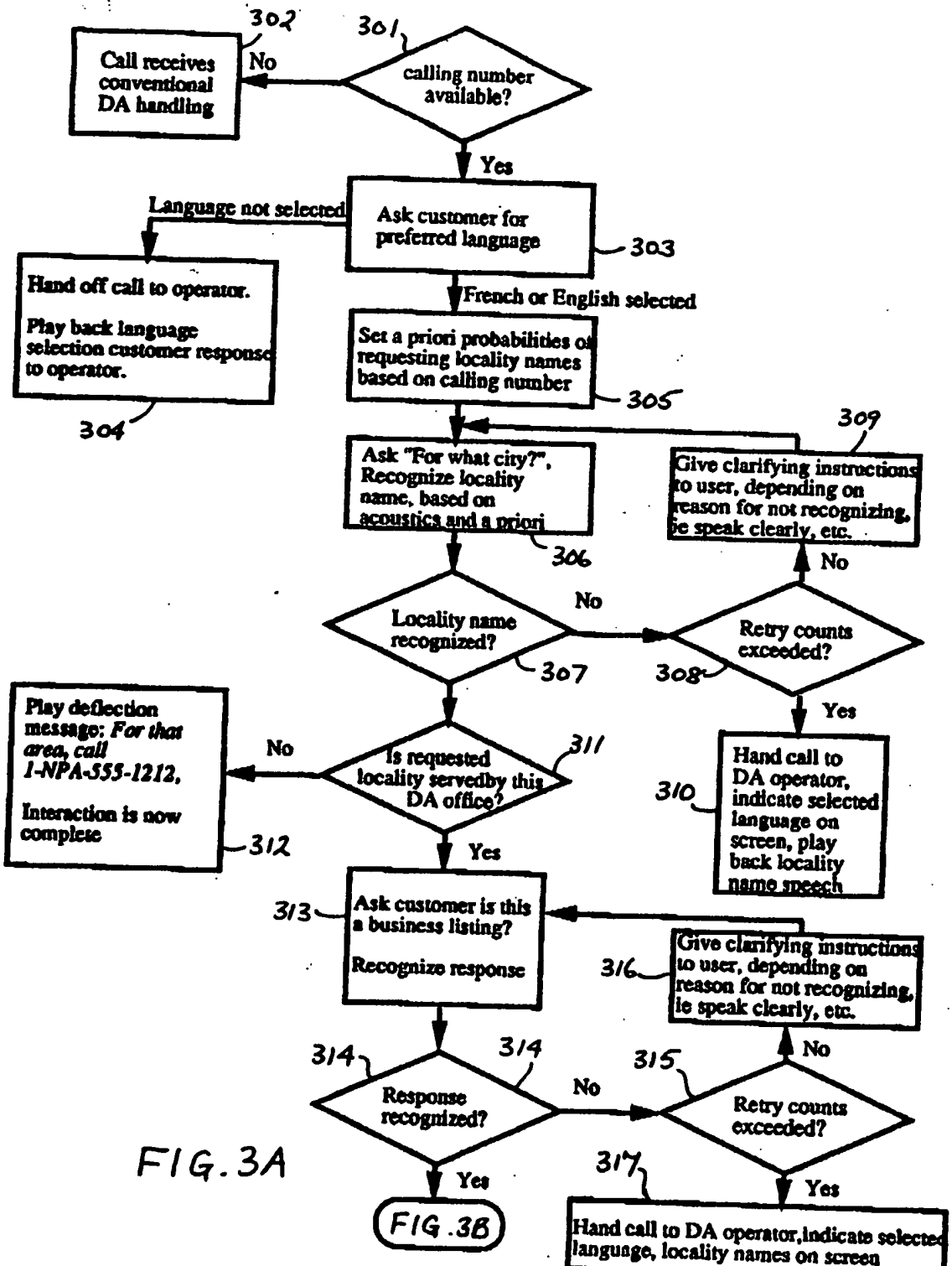



FIG. 3A

Thomas Adams & Assoc
AGENT FOR APPLICANT

FIG. 3A

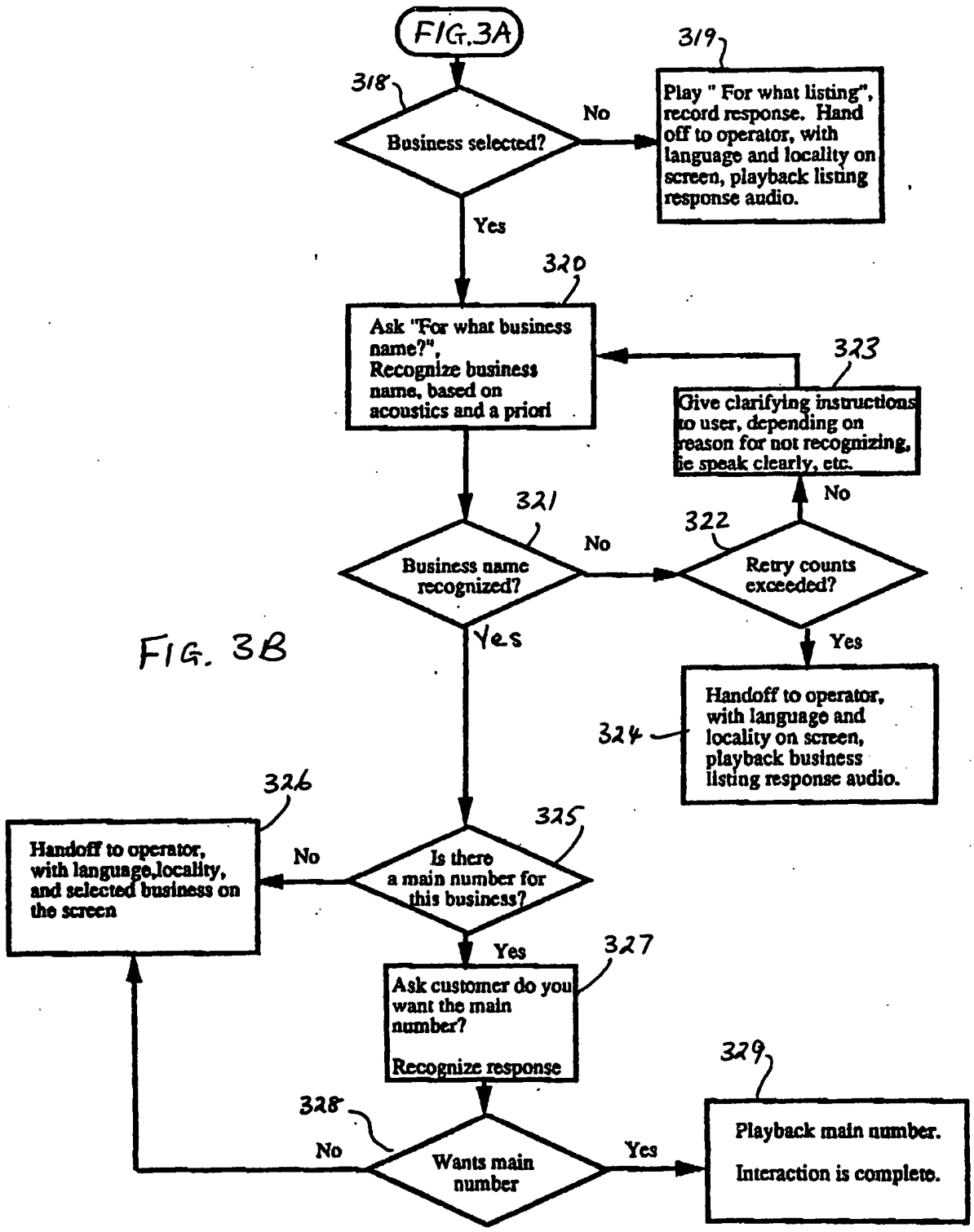



FIG. 3B

Thomas Adams & Voss
AGENT FOR APPLICANT

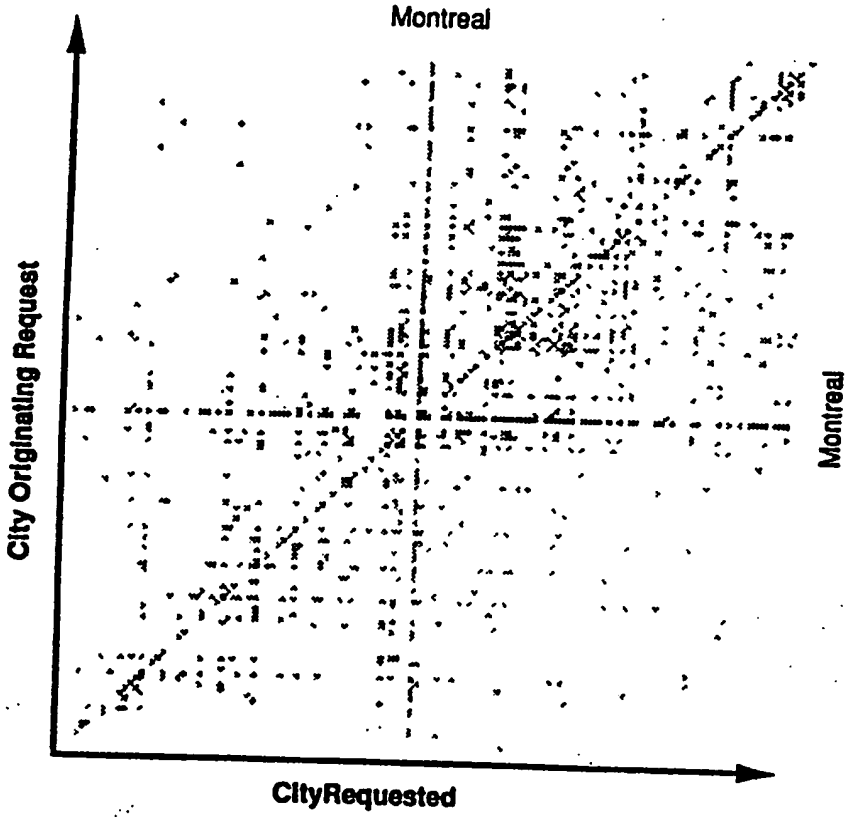
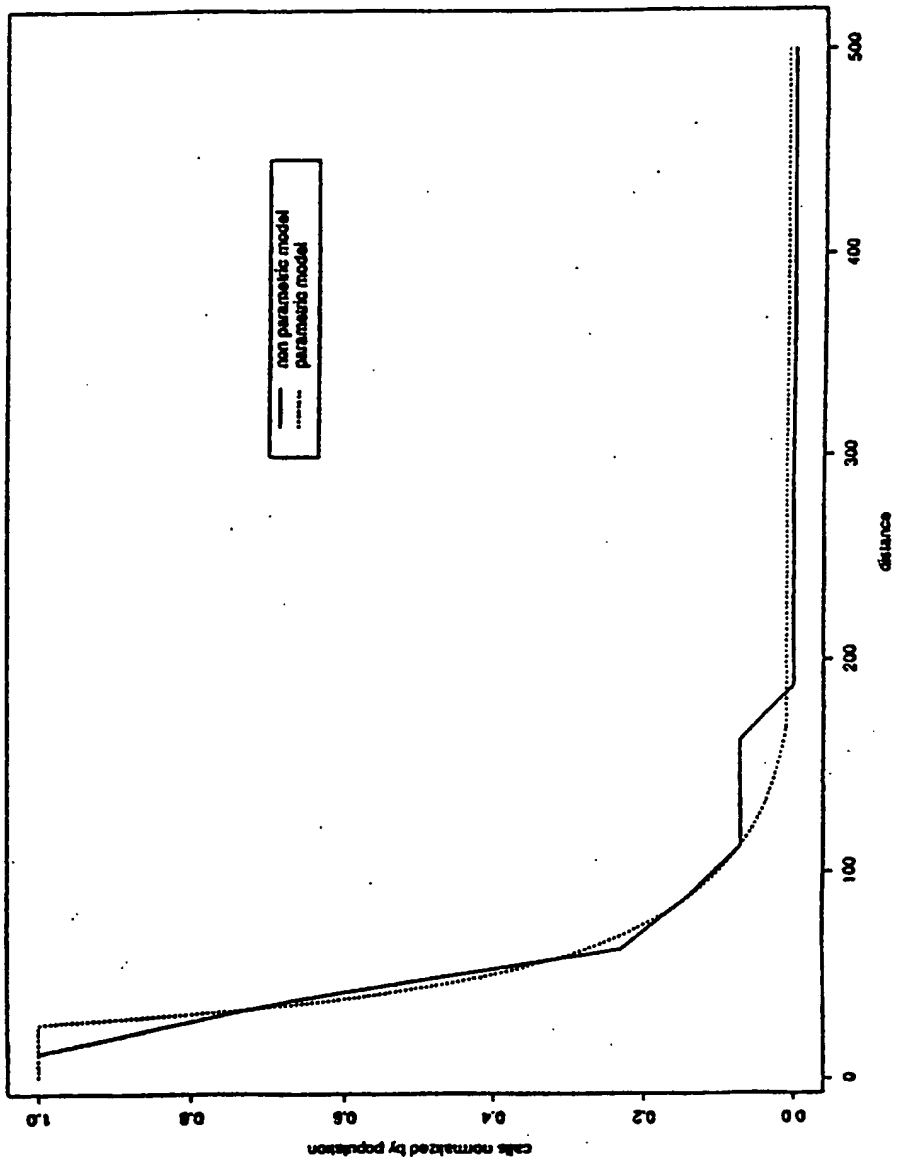



FIG. 4

Thomas Adams & Assoc.
AGENT FOR APPLICANT

FIG. 5




Thomas Adams & Rose

AGENT FOR APPLICANT